

0 What is claimed:

1. A maskless stereolithography method of forming a three-dimensional object from a plurality of adhered laminae by exposing successive layers of a material to a micro-focused energy beam generated by an array of Fresnel zone plates, comprising:

- 5 (A) providing a controllable array of Fresnel zone plates;
- (B) forming a layer of material adjacent to any last formed layer of material in preparation for forming a subsequent lamina of the object;
- (C) exposing the material to the micro-focused energy beam to form the subsequent lamina of the object; and
- 10 (D) repeating the steps of forming and exposing a plurality of times in order to form the object from a plurality of adhered laminae,

wherein the array of Fresnel zone plates are employed to focus parallel beamlets of energy beam from a source so that said beamlets converge to an array of focal points at predetermined positions of a lamina in accordance with a computer-aided design file of said object.

15 2. The method of claim 1 further comprising a step of operating means for modulating individual ones of said array of focal points.

 3. The method of claim 2, wherein said modulating means operates to selectively shut off and on said focal points.

 4. The method of claim 1, wherein said step of forming a layer of material comprises coating or re-coating a thin layer of photo-curable resin.

20 5. The method of claim 1, wherein said step of forming a layer of material comprises coating or re-coating a thin layer of a material composition comprising a photo-curable resin and fine ceramic and/or metallic particles.

 6. The method of claim 5, wherein said fine ceramic and/or metallic particles occupy at least 40%

0 by volume of said composition.

7. The method of claim 1, wherein said step of forming a layer of material comprises feeding a layer of fine ceramic and/or metallic powder particles and, concurrently or sequentially, spraying a predetermined amount of a photo-curable resin onto said layer of powder particles.

5 8. The method of claim 1, wherein said energy beam is selected from the group consisting of ultraviolet, laser, X-ray, Gamma-ray, atomic particle beam, or a combination thereof.

9. An apparatus for forming a three-dimensional object from a plurality of adhered laminae by exposing successive layers of a photo-curable material composition to a micro-focused energy beam, comprising:

- 10 (a) a work surface to support the object while being built;
- (b) material dispensing means disposed a distance from said work surface for feeding successive layers of a photo-curable material composition thereon, one layer at a time;
- 15 (c) a Fresnel zone plate sub-system disposed a distance above said successive layers of a photo-curable material composition for focusing an energy beam into an array of focal points to create a curing pattern on each of said successive layers for forming multiple laminae of said object;
- (d) a Fresnel zone plate controller comprising modulating means and being electronically connected to said Fresnel zone plate sub-system;
- 20 (e) motion devices coupled to said work surface, said Fresnel zone plate sub-system, and/or said material-dispensing means for moving said material-dispensing means and said Fresnel zone plate sub-system relative to said work surface in a plane defined by first and second directions and in a third direction orthogonal to said plane to dispense and cure said successive layers of a photo-curable material composition, one layer at a time, for forming said 3-D object.

25 10. The apparatus of claim 9, further comprising a computer that controls the operation of said Fresnel zone plate sub-system.

- 0 11. The apparatus of claim 9, further comprising motion control means electronically connected to said motion devices to control the operation of said motion devices.
12. The apparatus of claim 9, wherein said energy beam comprises X-radiation.
13. The apparatus of claim 9, wherein said modulating means comprises micro-mechanical shutters.
- 5 14. The apparatus of claim 9, wherein said modulating means comprises micro-mechanical mirrors.
- 10 15. The apparatus of claim 9, wherein said material dispensing means comprises:
a vat to contain the photo-curable material composition;
a moveable support platform disposed a distance from said vat, said platform providing a work surface on which said object is supported while being built; and
coating means disposed a distance from said work surface for feeding said successive layers of a photo-curable material composition thereto, one layer at a time.
- 15 16. The apparatus of claim 9, wherein said material dispensing means comprises:
powder-dispensing means having an outlet directed to said work surface for feeding successive layers of powder particles onto said work surface one layer at a time; and
adhesive sprayer means having an outlet directed to said successive layers of powder particles for spraying a layer of a photo-curable resin onto each of said successive layers of powder particles for forming said successive layers of a photo-curable material composition.